thus coinciding with the transmitted part of the first pencil; and the two pencils are thus brought to 'interfere.'[1] A little consideration will show that this arrangement is exactly equivalent to an air-film or plate between two plane surfaces. The interference phenomena are therefore the same as for such an air-plate.

If the virtual distance between the plane surfaces is small, white light may be employed, and we have then colored fringes like Newton's rings or the colors of a soap-film. If the distance exceeds a few wave-lengths, monochromatic light must be employed. We may confine our attention to the case of two parallel surfaces. Here it can readily be shown that the fringes are concentric circles, the common axis of the rings being the normal passing through the optical centre of the eye or telescope. Further, they are most distinct when the eye or the telescope is focused for parallel rays. In any other case we are troubled with the same perplexing changes of form and position of the fringes as already noted.

If, now, one of the mirrors have a motion normal to its surface, the interference rings expand or contract; and, by counting the fringes as they appear or disappear in the centre, we have a means of laying off any given distance in wave-lengths.

Should this work of connecting the arbitrary standard of length — the yard or the metre — with the unalterable length of a light-wave prove as feasible as it is hoped, a next step would be to furnish a standard of mass based upon the same unit.

Suppose a cube, ten centimetres on a side, with surfaces as nearly plane and parallel as possible. Next suppose a testing-instrument made of two parallel pieces of glass, whose inner surfaces are slightly farther apart than an edge of the cube. The parallelism and the distance of these surfaces can be verified to a twentieth of a wave. Now apply this testing-instrument to the three pairs of surfaces of the cube, and determine their form, parallelism, and distance to the same degree of accuracy. We have thus the means of measuring the volume of a cubic decimetre with an error less than one part in a million.

It does not seem extravagant to say that by some such plan as this we may obtain a standard kilogram which will be related to the standard of length with a degree of approximation far exceeding that of the present standard. The apparatus can also be used in the manufacture of plane surfaces, and in the measurement of co-efficients of expansion.

For all measurements of refraction and dispersion, — for solids and liquids as well as for gases, — and in the determination of the wave-length of standard lines, the accuracy of the measurement of absolute wave-lengths will depend on the accuracy with which the fixed distance can be compared with the standard metre; and this may be estimated as one part in a million.

The results of the remarkable work of Rowland do not claim a much greater degree of accuracy than one part in half a million for relative determinations; while the elaborate research of Bell on absolute wave-lengths claims but one in two hundred thousand.

It may possibly help to realize the very considerable superiority of this instrument over the grating — at any rate, for the class of work in question — if I recall to your attention the fact that by its means it has been possible to show that the red line of hydrogen is a very close double.

Closely connected with the preceding investigations is the study of the effect of the temperature, thickness, and density of the source on the composition of the radiations, as shown by the symmetrical or unsymmetrical broadening of the spectral lines, and the consequent shifting of their mean position. This question has quite recently been taken up by H. Ebert, and the results he has already obtained are very promising. Ebert has established two conclusions, which, if verified, are of the greatest importance: namely, first, that the chief factor in the broadening of the spectral lines is the increase in density of the radiating body; second, that the broadening, in all the cases examined, is unsymmetrical, causing a displacement of the line toward the red end of the spectrum. The importance of these conclusions, in their relation to the proper motions of the heavenly bodies and their physical condition, can hardly be overestimated. The value of results of this kind would, however, be much enhanced if it were possible to find a quantitative relation

[1] A second plane parallel plate of the same thickness and inclination is placed (for compensation) in the path of the first pencil.

between the density of the radiating substance and the nature of its radiations. In the case of hydrogen enclosed in a vacuum tube this could readily be accomplished. It may, however, be objected that it would be difficult in this case to separate the effects of increased density from those due to the consequent increase in the temperature of the spark. The problem of the temperature of the electric discharge in rarefied gases is one which has not yet been solved. In fact, it may seriously be questioned whether in this case temperature has any thing to do with the accompanying phenomena of light; and it appears to me much more reasonable to suppose that the vibratory motion of the molecules is not produced by collisions at all, but rather by the sudden release of tension in the surrounding ether.

BOOK – REVIEWS.

The Philosophy of Kant. By JOHN WATSON. New York, Macmillan. 8º. $1.75.

THE present volume consists of a number of extracts from Kant's principal works, — 'The Critique of Pure Reason,' 'The Metaphysic of Morality,' 'The Critique of Practical Reason,' and 'The Critique of Judgment,' — and is intended for the use of teachers of philosophy. Undoubtedly the study of Kant is the best introduction into modern philosophy, and a powerful means of guarding students from falling into a shallow materialism or positivism. The extracts are well selected, and the difficult task of rendering Kant into intelligible English without altering the character of his style too much has been skilfully solved. The book is an enlarged edition of the author's 'Extracts from Kant's Writings,' which was originally printed for the use of his own students. Professor Watson says that he found by experience the results obtained by means of lectures on philosophy very unsatisfactory, as the students did not learn to think for themselves: therefore he adopted the plan of supplementing his lectures by the study of the writings of various philosophers. This is the same method which is so successfully followed at German universities in what are called 'seminaries.' The teacher who will take this course will find Watson's book very useful and convenient, as it contains the salient points of Kant's philosophy.

Latin Accidence and Exercises. By W. WELCH and C. G. DUFFIELD. London and New York, Macmillan. 24º. 40 cents.

THIS book is intended as an introduction to Macmillan's 'Elementary Classics.' The principles on which the authors' plan is based are a thorough and accurate mastery of the elements of the Latin language, and the putting into intelligent practice at once what has been learned, thus avoiding as much rote-work as possible. The examples have been taken largely from the 'Public Schools Latin Primer,' as the latter is most widely used in the higher forms. The authors do not deem it desirable that beginners should learn the conjunctive mood, which, for this reason, has been added in small type at the end of the 'Accidence.' The book is intended to be mastered in two terms.

Elementary School Atlas. By J. BARTHOLOMEW. London, Macmillan. 8°. 30 cents.

THE publication under review belongs to Macmillan's Geographical Series, edited by A. Geikie, who promoted the interests of teaching geography so well by his well-known essay on this subject. As might be expected, the atlas represents a great improvement upon the ordinary English elementary school-maps, the material which is embodied in the maps being carefully selected, and the abominable relief-plate printing being at last discarded, a clear lithograph taking its place. The atlas contains twenty-four maps or plates. The first shows a number of hemispheres: the northern and southern (land and water) and the European and South American. We would gladly miss the last, as it is intended only to show the central position of Europe. The second map is named 'Europe, illustrating Geographic Terms.' This map must be considered a failure, as it attempts the explanation of geographic terms, instead of by means of objects, by that of a highly and wrongly generalized map. The following plate, which illustrates the mapping of a landscape and the influence of reduction, ought